

Linac Front-End R&D --- Systems Integration and Meson Lab Setup

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Talk Outline

- **Motivation and context of schedule**
- **R&D plan**
- **R&D objectives**
- **Manpower resources and needs**
- **R&D facilities**
- **Schedule**
- **Conclusion**

Motivation and Timeline

- **Motivation – Demonstrate key and un-tested technologies important to the low-energy front-end ($\beta < 0.4$) section of the proposed 8 GeV H- Linac**
- **Timeline – Accomplish the R&D necessary to establish technical credibility and cost basis for the Linac front-end by ~2010**

R&D Plan

- Install and commission 2.5 MW, 325 MHz klystron system
- Equip and operate a 325 MHz high power RF component test facility
- Fabricate, install, and operate a test cryostat for 325 MHz SC spoke cavities
- Construct and test key components of the low-energy Linac concept
- Assemble the 10 MeV RT Linac, operate with beam, and verify performance
- Install 325 MHz SC spoke resonator cryomodules and operate with beam up to 90 MeV

This all adds up to building a one-of-a-kind superconducting 90 MeV H- linac

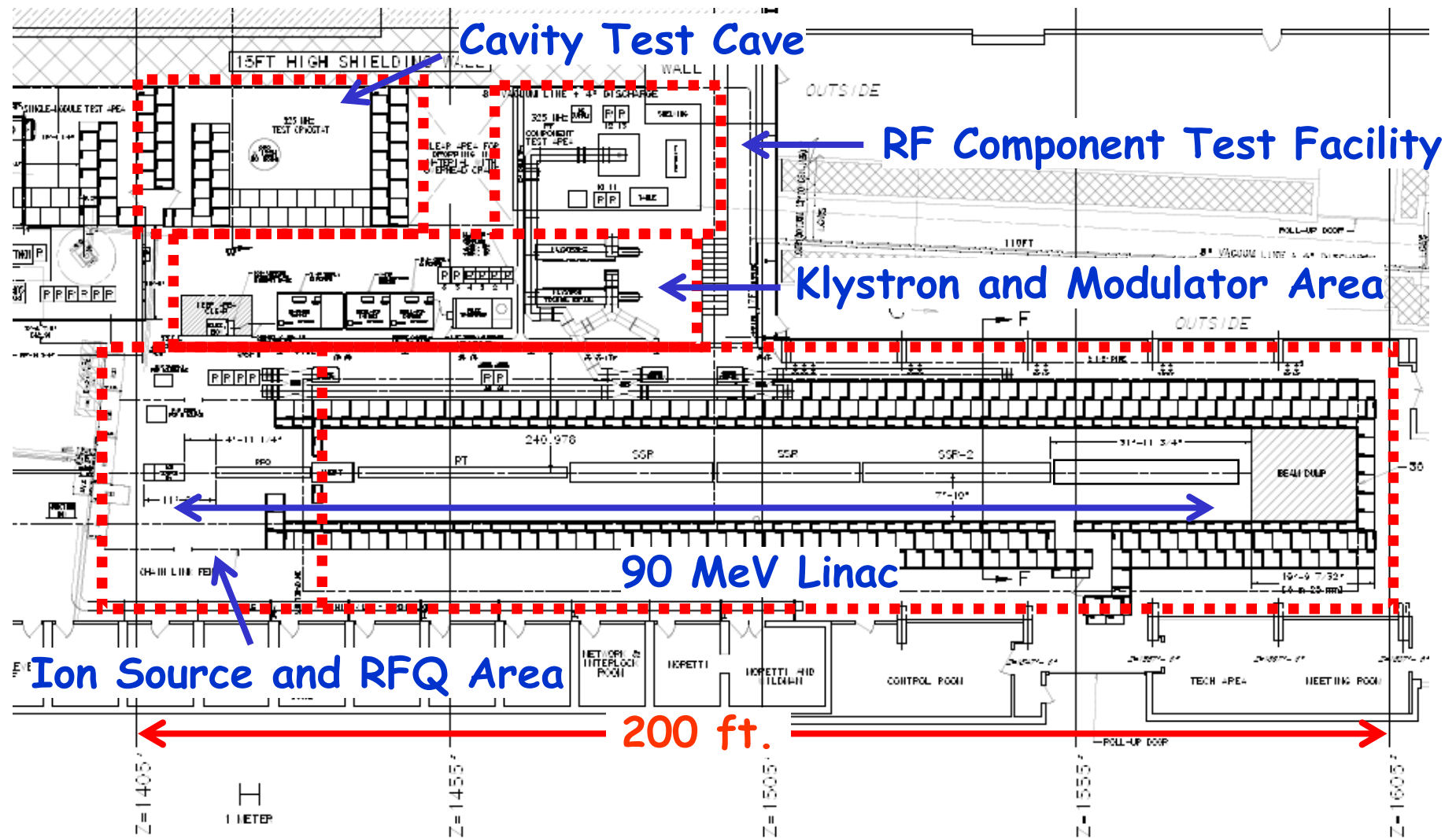
R&D Objectives

- **Demonstrate high power RF distribution and 4.5 millisecond pulse operation of multiple cavities from a single klystron**
- **Demonstrate device and system performance of high power vector (IQM) modulators for amplitude and phase control of multiple cavities**
- **Measure axially-symmetric beam performance with RT-CH (room temperature, crossbar H-type) spoke resonator cavities and SC solenoid focusing in the RT Linac**
- **Demonstrate low transition energy to superconducting accelerating structures (10 MeV)**
- **Demonstrate application of superconducting spoke resonator RF structures in low beta Linac**
- **Demonstrate high-speed (nanosecond) beam chopping at 2.5 MeV**
- **Demonstrate performance of this Linac concept and resulting beam quality to 90 MeV**

Major Activity Areas in Meson

- **325 MHz Klystron and Modulator Area**
- **325 MHz RF Component Test Facility**
- **Cavity Test Cave (RT-CH and superconducting cavities)**
- **Ion Source, RFQ, and 2.5 MeV Absorber Area**
- **90 MeV Accelerator and Beam Absorber Cave**

Meson Building Floor Plan



325 MHz Klystron and Modulator Area

- **Equipment**

- Modulator
- Klystron
- Waveguide, circulator, power divider, waveguide switch and RF load
- Low level electronics

- **Activities**

- Commission and operate klystron power system

View Into Klystron/Modulator Area



325 MHz 2.5MW Klystron



Klystron X-Ray Shield



4.5 msec Klystron Pulse Transformer



325 MHz Waveguide Circulator



325 MHz RF Component Test Facility

- **Equipment**
 - Waveguide with shuttered component test interface
 - DC/pulsed medium power supplies
 - Low level and diagnostics electronics
- **Activities**
 - Installation and testing of various 325 MHz RF components over a wide range of RF power levels

Waveguide Components



325 MHz Cavity Test Cave

- **Equipment**

- Facilities for power testing of room temperature and superconducting RF cavities
- Cavity test cryostat
- Vacuum equipment
- Low level and diagnostics electronics

- **Activities**

- Install and test various 325 MHz RF cavities (RT-CH and superconducting) up to full power ($\sim 100\text{KW}$ maximum pulsed)

Ion Source, RFQ and 2.5 MeV Beam Area

- **Equipment**

- Ion source and associated high voltage power supply equipment
- DC/pulsed medium power supplies
- 325 MHz RFQ
- Beam absorber
- Low level and diagnostics electronics

- **Activities**

- Commission and operate 2.5 MeV beam at maximum
~500 watts intermittent beam power

Linac and Absorber Enclosure

- **Equipment**

- Accelerating cavities, RF power distribution, other beam line components, and all utilities and support equipment required to accelerate protons or H⁻ ions to 90 MeV
- Beam absorber

- **Activities**

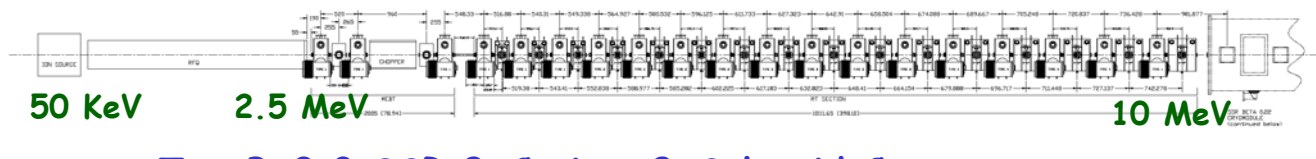
- Commission and operate 90 MeV beam at maximum ~10KW intermittent beam power

View Down (Future) Linac Beam Line

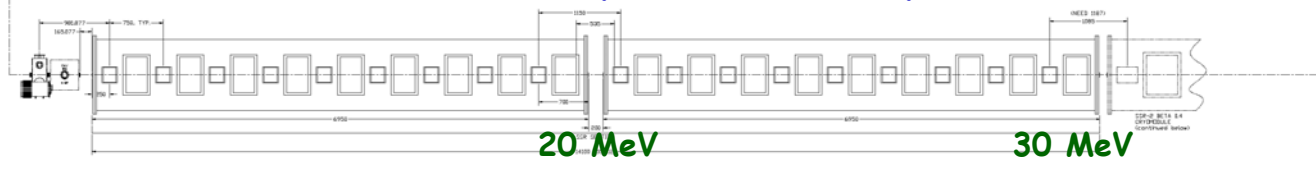


Layout Through Second $\beta=.4$ Cryostat

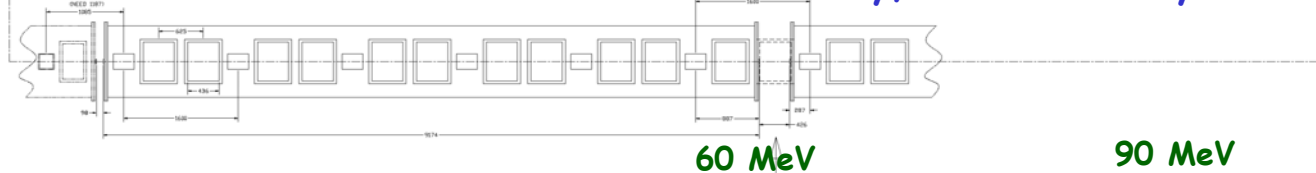
Ion Source RFQ MEFT Room Temperature 16-Cavity, 16 SC Solenoid Section



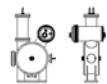
Two B=0.2 SSR 9-Cavity, 9-Solenoid Cryostats



Two B=0.4 SSR 11-Cavity, 6-Solenoid Cryostats

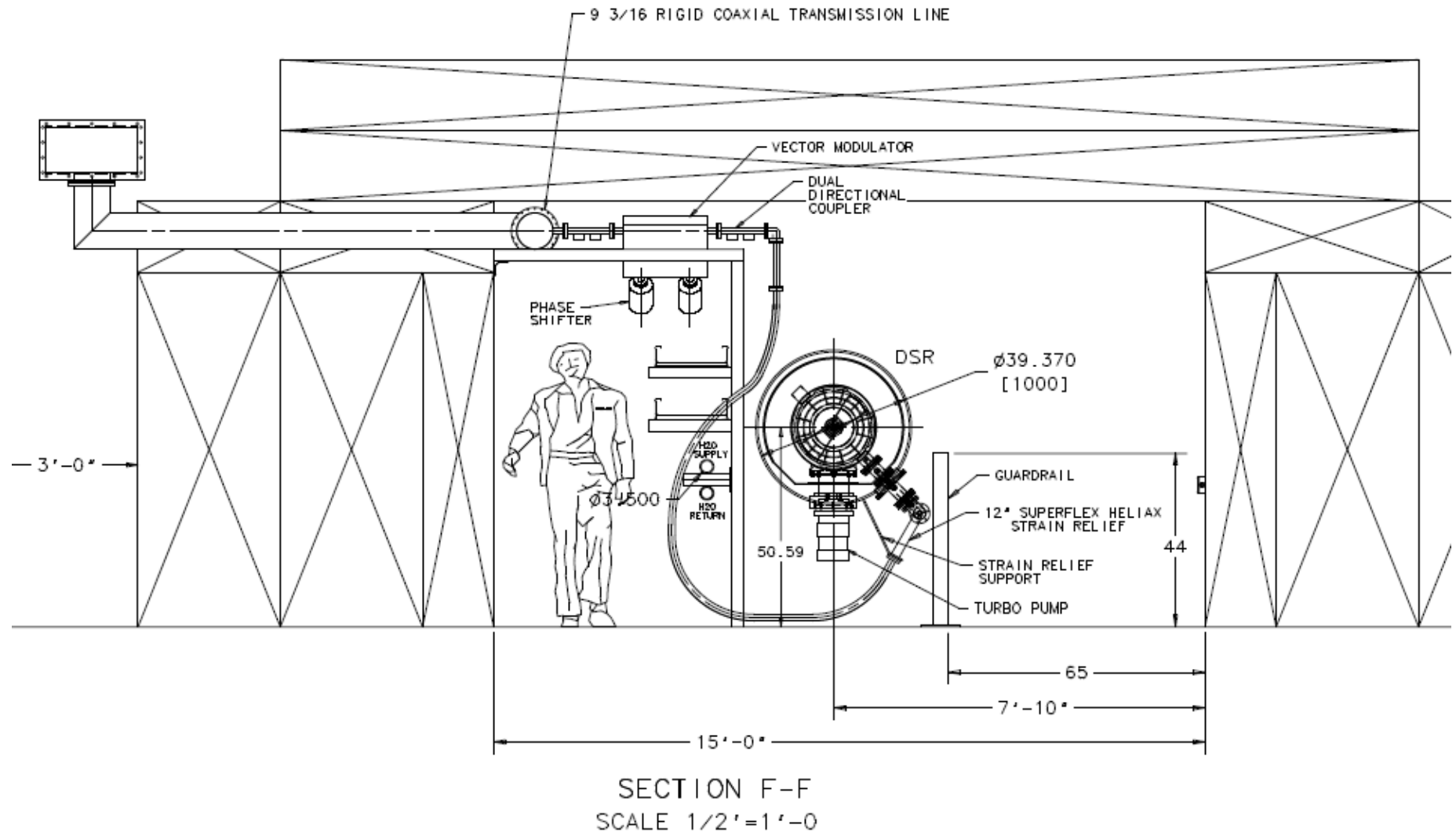


SOLENOID



MESON R&D PROJECT STOPS HERE

Meson Linac Cave Cross-section



Meson Schedule 2006

- **Short “mock” Linac cave section available**
 - May 2006
- **Klystron modulator completion**
 - July 2006
- **325 MHz RF power system commissioning**
 - July 2006
- **325 MHz component testing in RF test area**
 - Starting August 2006
- **325 MHz RT cavity power testing in cavity test cave**
 - September 2006
- **Superconducting cavity test cryostat installation**
 - October 2006
- **Ion Source installation in Meson**
 - November 2006

Meson Schedule 2007

- **RFQ (now in procurement) delivery and power testing**
 - January 2007
- **RT cavity and coupler testing**
 - Starting February 2007
- **2.5 MeV beam tests**
 - Beginning February 2007
- **First SC spoke resonator power tests in test cryostat**
 - April 2007
- **Linac cave construction and utilities installation**
 - May 2007
- **Demonstration of multiple cavity RF distribution and independent amplitude & phase control**
 - July 2007
- **Beam accelerated through first 'N' RT cavities**
 - September 2007

Meson Schedule 2008

- **Full 10 MeV RT linac installed**
 - April 2008
- **R&D beam operations at 10 MeV**
 - Starting May 2008
- **First SC spoke resonator cryomodule installation**
 - October 2008
- **Tests of RT + SC cavity RF distribution and independent amplitude & phase control**
 - November 2008
- **Beam through first SC spoke cryomodule**
 - December 2008

Manpower Resources

- **A Lab-Wide effort is required and now being applied**
 - Beam line components are designed and procured by Technical Division
 - RF and conventional power source components and systems integration and operation are the responsibility of the Accelerator Division
 - Particle Physics Division is supplying manpower for utilities and infrastructure installation in the Meson building
 - Laboratory Safety Section and Accelerator Division Safety Department are already at this early stage actively involved
- **Key technical systems now lacking required attention**
 - RF power distribution system (tightly coupled with cavity design status and power requirements)
 - Low level RF systems – system design, modeling, hardware (partially mitigated via LBNL MoU)
 - Cryogenics delivery system engineering for the Meson Linac cave
 - Beam instrumentation design (partially mitigated by BNL MoU)

Summary

- **Considerable activity is now underway on component design, procurement, and facilities to support planned R&D**
- **It will be an exciting next 12 months to bring 325 MHz klystron and RFQ on-line and to accelerate beam in the Meson Building**
- **Key areas, presently lacking effort necessary to maintaining desired schedule, have been identified**

Back-up Slides

Meson Building Floor Plan

